PROJECT

Biological and chemical control of the black vine weevil (*Otiorhynchus sulcatus*)
(4102)

INTERNAL REPORT

EXPERIMENTS

Control of the larvae of the black vine weevil in pots and in the field - 1994/95
Boskoop 1995 (4102-32, 4102-33)

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SAMENVATTING

Bestrijding van de larven van de gegroefde lapsnuitkever in potten en in de vollegrond 1994/1995
Boskoop 1995
Intern verslag(en) 4102-32 en 4102-33
Auteur
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De chemische bestrijding met het standaardmiddel carbofuran (Curater vlb.) in potten geeft slechts een matige bestrijding van 50%. Het standaardmiddel chloorpyrifos (Asepta Suscon10) geeft een maximale bestrijding (100%). In de vollegrond geeft carbofuran slechts een bestrijding van 40% hetgeen in overeenstemming is met de resultaten van de afgelopen jaren.

Code1 * is een effectief chemisch middel. In potproeven zijn de resultaten de afgelopen jaren constant goed. Bij een concentratie van 12,5 tot 25 g/ha (80% a.i.) is er een maximale bestrijding. In de vollegrond waren de resultaten met de 20% a.i.-formulering goed. Met de nieuwe formulering (80% a.i.) en een lagere dosering zijn de resultaten dit jaar minder goed. Volgend jaar zal met deze nieuwe formulering een dosis van 50 en 100 g/ha worden aangehouden.

Code2* geeft variabele resultaten in de loop van de tijd en wordt daarom niet gezien als een goed bestrijdingsmiddel van de larven van de taxuskever.

Code3 geeft een matige bestrijding. Variatie van de dosis heeft geen effect op het bestrijdingsresultaat. Het effect van de verschillende produktformuleringen op de bestrijding is niet duidelijk.

Van de geteste aaltjesstammen is het produkt Larvanem (*Heterorhabditis* sp.(NWE)(NI-H-F85)) als beste naar voren gekomen in zowel de pot- als veldproeven. Hoewel er aanwijzingen zijn voor een dosis-mortaliteit effect kan dit niet worden aangetoond na statistische analyse.

De engelse aaltjesstam (Nemasys H) geeft dit jaar slechts een matige bestrijding. Er is reden om aan te nemen dat de mindere kwaliteit van het produkt verantwoordelijk is voor dit resultaat. Vergelijking van de oude gel-formulering met de huidige kleiformulering in een veldproef kan hier uitsluitsel over geven.

Steinernema feltiae (NZ-S-CA) geeft een goed bestrijdingsresultaat in potten. Het resultaat is vergelijkbaar met 1993. Verlaging van de dosering geeft een sterke achteruitgang in werkzaamheid. In de vollegrond zijn de resultaten redelijk, echter ook hier zal de proef herhaald moeten worden met een betere kwaliteit alen bij een concentratie van 1,0x10E6/m^2 voordat deze stam definitief kan worden beoordeeld op haar effectiviteit.

Hoewel een verlaging van de dosis van de aaltjesstammen met 50% in potten en in de vollegrond een evengoede werking geeft als bij de hogere doseringen die in de praktijk worden geadviseerd zullen nog enkele extra proeven moeten worden gedaan om te zien of de resultaten consistent zijn en optimaal over meerdere jaren.

De met * gecodeerde middelen zijn niet toegelaten in de boomkwekerij voor dit doel.

SUMMARY

Control of the larvae of the black vine weevil in pots and in the field 1994/1995.
Boskoop 1995
Internal report experiment(s) 4102-32 and 4102-33
Author
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The standard chemical treatment in pots with carbofuran (Curater Iq.) is only moderate effective (~50%) against the larvae of the black vine weevil. The new standard chloorpyrifos (Suscon10) is however very successful (100% control). In the field carbofuran is giving low reductions (~40%) which is a consistent result for the last years.

Code1* is an effective chemical. In pots the results are constant high during the last years. A concentration of 12.5 to 25 g/ha (80% a.i.) is giving maximum control. In the field the results with the 20% a.i. formulation were good during the last years. With the new formulation (80% a.i.) and a lower dose of the product formulation the results were only moderate this year. Next year the dose should therefore be raised to 50 and 100 g/ha (80% a.i.).

Code2* is giving variable results over the last years and is therefore considered to be not effective as a treatment against the larvae of the black vine weevil.

Code3 is giving only moderate results. Variation in the concentration applied is having no effect on the control. The effect of different product formulation on efficacy is not clear.

Of the tested nematode strains *Heterorhabditis* sp.(NWE)(Nl-H-F85) was the most effective one in the pot trial and in the field. Although there are indications for a dose-mortality effect it was not found after statistical analysis.

The UK-strain (Nemasys H) is giving only moderate results. There is reason to believe that a reduced quality of the product is causing this effect. Comparison of the former gel-formulation with the today's clay-formulation in a field trial is advisable.

Steinernema feltiae (NZ-S-CA) is giving good control results in pots. The result is comparable with the results of 1993. Lowering the dose is giving a strong reduction in efficacy. In the field the results are reasonable but application with a good batch of nematodes at 1.0x10E6/m^2 is needed before this strain can be evaluated for its efficacy.

Although 50% reduction in the concentration of nematodes applied in the pots and the field are giving no statistically different results with the advised higher doses some more trials have to be performed to be sure that it is giving consistent and optimal control in time.

The with * coded means or treatments are not registered in nursery stock for the purpose used in this research.

TRIAL 4102-32: CONTROL OF THE LARVAE OF THE BLACK VINE WEEVIL IN POTS.

MATERIAL AND METHODS

There are 18 treatments in 4 blocks with 8 plants per block. The plants were inoculated twice with respectively 20 and 15 eggs per plant. The plants were inoculated on 18 july and 15 august 1995. As a test plant we used *Waldsteinia ternata.* The plants were potted in spring in one litre pots and placed in open boxes on the container field. The treatments were separated by non-treated plants. The border plants of the experiment were surrounded by non-treated plants to exclude the influence of heating the pot soil by direct sunlight on the side of the pots. The substrate used in the pots consisted of 55% pellets, 40% sphagnum-moss peat and 5% aeolian sand. The temperature of the soil in the pots was measured every 60 minutes with a Rologg NT1 temperature datalogger (appendix 1: graphics).

Treatment 3 was performed during potting of the plants in spring 1994. The treatments 2, 4, 5 and 6 were performed on 4 july 1994 for the first time and on 23 august 1994 for the second time.

The treatments with nematodes (7 up to 14) were performed on 19 september 1994 between 16.00 and 17.00 hour (weather: rain, cloudy, ~12°C). The nematodes as well as the chemical treatments 2, 4, 5 and 6 were applied in 25ml. water per pot.

Table 1 - Treatments pot experiment.

active ingredient	commercial	dose	%ai#	number@
1. control	-	-	-	-
2. carbofuran	Curater vlb.	37.5 l/ha	20	2x(27,34)
3. chloorpyrifos	Suscon10	375 kg/ha	10	1x(16)
4. code1*	EXP60720A	12.5 g/ha	80	2x(27,34)
5. code1*	EXP60720A	25 g/ha	80	2x(27,34)
6. code2*	Mocap 20GS*	25 kg/ha	20	2x(27,34)
7. *S.feltiae* (NZ-S-CA)	Westerman	0.5 10^6/m^2	-	1x(38)
8. *S.feltiae* (NZ-S-CA)	Westerman	0.25 10^6/m^2	-	1x(38)
9. *H.* sp.(NWE)(UK-H-211)	Nemasys H	125,000/m^2	-	1x(38)
10. *H.* sp.(NWE)(UK-H-211)	Nemasys H	0.25 10^6/m^2	-	1x(38)
11. *H.* sp.(NWE)(UK-H-211)	Nemasys H	0.5 10^6/m^2	-	1x(38)
12. *H.* sp.(NWE)(NI-H-F85)	Larvanem	125,000/m^2	-	1x(38)
13. *H.* sp.(NWE)(NI-H-F85)	Larvanem	0.25 10^6/m^2	-	1x(38)
14. *H.* sp.(NWE)(NI-H-F85)	Larvanem	0.5 10^6/m^2	-	1x(38)
15. code3	code3	-	-	-
16. code3	code3	-	-	-
17. code3	code3	-	-	-
18. code3	code3	-	-	-

%ai = percentage active ingredient

@ number = number of sprayings. Between parentheses the week number of treatment

The experiment ended in week 48 (november). The soil in each pot was searched for the presence of larvae. Of each larva the size was noted (five instars (L1 to L5) of the larvae and one pupal stage). The larvae were washed and put into a petri dish for a few days to see if any of the living larvae were infected.

The total number of larvae found and the number of L2, L3 and L4 are noted in the database (appendix 2) and used for statistic analysing. There were no L1, L5 or pupae found. The data are analysed with ANOVA. The values are transformed to square root numbers before analysing.

RESULTS

The results are summarized in table 2. The number of larvae are an average of the 4 blocks and are shown in the table as number of larvae per plant. The results are statistically analysed with ANOVA. The results of this analysis are shown in the table.

Table 2 - Mean number of larvae per plant (n) and percentage reduction compared to control in the pot experiment (4102-32).

behandeling	n	total%#	L2%#	L3%#	L4%#
1. control	3.3	0 a	0 bc	0 a	0 a
2. carbofuran	1.6	51 bcd	21 bc	51 bcd	84 de
3. chloorpyrifos	0.0	100 g	100 g	100 g	100 e
4. code1*	0.1	98 g	94 g	100 g	100 e
5. code1*	0.0	99 g	97 g	100 g	100 e
6. code2*	4.2	0 a	0 a	5 ab	0 a
7. *S.feltiae* (NZ-S-CA)	0.5	86 ef	91 fg	85 efg	81 cde
8. *S.feltiae* (NZ-S-CA)	2.3	33 bc	24 bc	27 abc	50 bc
9. *H.* sp.(NWE)(UK-H-211)	1.3	63 de	68 defg	49 cde	75 cde
10. *H.* sp.(NWE)(UK-H-211)	2.0	40 bc	0 b	29 abc	97 e
11. *H.* sp.(NWE)(UK-H-211)	1.2	63 cd	73 efg	58 cde	60 bcd
12. *H.* sp.(NWE)(NI-H-F85)	0.9	73 def	76 efg	73 defg	72 cde
13. *H.* sp.(NWE)(NI-H-F85)	1.2	65 de	35 bcde	68 def	91 e
14. *H.* sp.(NWE)(NI-H-F85)	0.4	88 fg	71 efg	95 fg	97 e
15. code3	1.4	57 bcd	71 efg	68 def	28 ab
16. code3	2.2	36 b	0 b	35 abc	81 cde
17. code3	1.6	52 bcd	53 cdef	24 abc	88 e
18. code3	1.3	61 bcd	32 bcd	71 def	78 e

\# percentage reduction based on number of larvae. Statistical results (letters behind figures) are based on square root transformation of number of larvae. Numbers higher than n in the control (3.3) are set to 0% reduction.
The population in the control consisted for 32% of L2-larvae, 38% of L3-larvae and 30% of L4-larvae.

Figures in the same column followed by the same letter are not statistically significantly different, with a 95% confidence limit.

As the graphs in appendix 1 show the temperature in the soil is average above 12°C until 3 october and drops than to general lower temperatures with only short peaks above this temperature late october and in november.

The standard chemical treatment in pots with carbofuran (Curater Iq.) is only moderate effective (~50%). The new standard chloorpyrifos (Suscon10) is however very successful (100% control).

Code2* was not effective. Code1* (80% a.i.) was effective in the pot trial at both concentrations.

Code3 is giving variable and moderate control. The two product formulations and the variation in concentration applied are having no effect on the results.

With the normal application of 0.5x10E6 nematodes/m^2 the tested strain *Heterorhabditis* sp.(NWE)(NI-H-F85) approved to be most effective (88% control) together with *Steinernema feltiae* (NZ-S-CA) (86% control) and followed by *Heterorhabditis* sp.(NWE) (UK-H-211) with 63% control. There seems to be no dose-mortality effect although the results do suggest an effect of increasing efficacy at the highest doses.

The UK-strain of Nemasys H is giving only very moderate results. Since the change of formulation from gel to clay the results with Nemasys H are more variable and generally lower. It is important to check if this could be the cause for the moderate/variable results of the last two years.

The results with *Steinernema feltiae* (NZ-S-CA) are promising like in 1993. The results are only good at the high dose of 0.5x10E6/m^2.

TRIAL 4102-33: CONTROL OF THE LARVAE OF THE BLACK VINE WEEVIL IN THE FIELD

MATERIAL AND METHODS

There are 18 treatments in 3 blocks with 5 plants per block surrounded by 12 border plants. The plants were inoculated twice with respectively 40 and 17 eggs per plant. The plants were inoculated on 11 july and 10 august 1995. As a test plant we used *Taxus baccata.* The plants were planted in spring. The temperature of the soil was measured every 60 minutes with a Rologg NT1 temperature datalogger (appendix 1: graphics).

The treatments 2, 13, 14 and 15 were performed on 4 july 1994 for the first time and on 18 august 1994 for the second time.

The treatments with nematodes (except treatment 17) were performed on 19 september 1994 between 16.00 and 17.00 hour (weather: rain, cloudy, ~12°C). The nematodes as well as the chemical treatments were applied in 3 litre water per m^2.
Treatment 17 was performed on 23 september 1994 because there were not enough nematodes available in this batch. The quality of the batch we applied on 23/9 was very poor.

Table 3 - Treatments field experiment.

active ingredient	commercial	dose	%ai#	number@
1. control	-	-	-	-
2. carbofuran	Curater vlb.	37,5 l/ha	20	2x(27,33)
3. *H.* sp.(NWE)(UK-H-211)	Nemasys H	250,000/m^2	-	1x(38)
4. *H.* sp.(NWE)(UK-H-211)	Nemasys H	500,000/m^2	-	1x(38)
5. *H.* sp.(NWE)(UK-H-211)	Nemasys H	10E6/m^2	-	1x(38)
6. *H.* sp.(NWE)(NI-H-F85)	Larvanem	250,000/m^2	-	1x(38)
7. *H.* sp.(NWE)(NI-H-F85)	Larvanem	500,000/m^2	-	1x(38)
8. *H.* sp.(NWE)(NI-H-F85)	Larvanem	10E6/m^2	-	1x(38)
9. code3	code3	-	-	-
10. code3	code3	-	-	-
11. code3	code3	-	-	-
12. code3	code3	-	-	-
13. code1*	EXP60720 A	25 g/ha	80	2x(27,33)
14. code1*	EXP60720 A	50 g/ha	80	2x(27,33)
15. code2*	code2*	100 kg/ha	20	2x(27,33)
16. *S.feltiae* (NZ-S-CA)	Westerman	500,000/m^2	-	1x(38)
17. *S.feltiae* (NZ-S-CA)	Westerman	10E6/m^2	-	1x(38)
18. code3	code3	code3	-	-

%ai = percentage active ingredient
@ number = number of sprayings. Between parentheses the week number of treatment

The experiment ended in week 7 (february 1995). The rootball of each plant was searched for the presence of larvae. Of each larva the size was noted (five instars (L1 to L5) of the larvae and one pupal stage). The larvae were washed and put into a petri dish for a few days to see if any of the living larvae were infected.

The total number of larvae found and the number of L2, L3, L4 and L5 are noted in the database (appendix 2) and used for statistic analysing. There were no L1 or pupae found. The data are analysed with ANOVA. The values are transformed to square root numbers before analysing.

Tabel 4 - Mean number of larvae per plant (n) and percentage reduction compared to control in the field experiment (4102-33).

behandeling	n	total %#	L2%#	L3%#	L4%#	L5%#
1. control	7,6	0 ab	0 bcd	0 bcd	0 ab	0 a
2. carbofuran	4,7	39 d	0 abc	0 abcd	43 cdef	85 fgh
3. *H.*sp.(NWE)(UK211)	7,1	7 abc	0 ab	0 ab	0 ab	48 abc
4. *H.*sp.(NWE)(UK211)	4,2	45 d	0 abc	0 bcde	24 abcd	70 defg
5. *H.*sp.(NWE)(UK211)	4,6	40 cd	0 bcd	21 bcdef	0 abc	74 efgh
6. *H.*sp.(NWE)(NIF85)	1,2	84 fg	63 cd	68 fg	95 g	88 ghj
7. *H.*sp.(NWE)(NIF85)	1,7	77 fg	0 abcd	68 fg	67 efg	94 hj
8. *H.*sp.(NWE)(NIF85)	0,5	94 g	50 cd	100 e	86 fg	100 j
9. code3	3,1	60 de	12 bcd	16 bcdef	57 cdef	79 efgh
10. code3	3,6	53 de	50 cd	74 efg	43 cdef	50 bcde
11. code3	1,8	76 ef	87 d	95 g	67 efg	73 defg
12. code3	7,5	2 a	0 bcd	0 ab	0 a	29 ab
13. code1*	3,1	59 de	12 abcd	58 defg	52 defg	67 cdef
14. code1*	4,7	39 d	63 cd	53 defg	33 bcde	33 abc
15. code2*	8,3	0 a	0 ab	32 abcd	0 abcd	11 a
16. *S.feltiae* (NZCA)	3,3	56 de	63 cd	21 bcdef	48 bcdef	68 defg
17. *S.feltiae* (NZCA)	6,3	17 abc	0 a	0 a	0 abc	73 efg
18. code3	4,9	36 bcd	87 d	37 cdef	0 abc	41 bcde

\# percentage reduction based on number of larvae. Statistical results (letters behind figures) are based on square root transformation of number of larvae. Numbers higher than n in the control (7.6) are set to 0% reduction.
The population in the control consisted for 7% of L2-larvae, 17% of L3-larvae 18% of L4-larvae and 58% of L5-larvae.

Figures in the same column followed by the same letter are not statistically significantly different, with a 95% confidence limit.

As the graphs in appendix 1 show the temperature in the soil is average above 12°C until 3 october and drops than to general lower temperatures with only short peaks above this temperature late october and in november.

The standard chemical treatment carbofuran is giving low reduction (~40%) which is a consistent result for the last years.

Code2* was not effective. Code1* (80% a.i.) was not as effective as last year (70 to 80% control). Although we applied 50% more a.i. per m^2 we only reached 40 to 60% control. The reason for this result is not clear. The new formulation and/or the mobility of the formulation in soil could be the reason for this result. In 1995 we will use 100 g/ha (80% a.i.) in the field trial. Code3 was not tested before. The results are reasonable but variable. The influence of product formulation and concentration on control is not clear.

With the normal application of 1.0x10E6 nematodes/m^2 the tested strain *Heterorhabditis* sp.(NWE)(NI-H-F85) approved to be most effective (94% control) followed by the UK-strain with 40% control. Treatment with *Steinernema feltiae* (NZ-S-CA) 1.0x10E6/m^2 (17) has failed because of the bad quality of the nematodes and cannot be compared with the other treatments. Comparing the results of the 0.5x10E6 nematodes/m^2 is showing the same rank order as with the higher application rates. *Steinernema feltiae* (NZ-S-CA) is as good as the UK-strain with approximately 50% control. There is no clear dose-mortality effect found looking at the total reductions. But looking at the reduction of L5 (58% of population!) there is an effect for the UK-strain (from 500,000/m^2 with 48% control to 1x10E6/m^2 with 70% control). Although not significant there is also a dose efect visible for the HF85-strain.

The UK-strain of Nemasys H is giving only very moderate results in the field. The results in the field show that the UK-strain is effective against the older larvae and not against the younger ones. This suggests that the nematodes were effective at application time for a very short period. The quality of the nematodes must have been moderate therefore. Since the change of formulation from gel to clay the results with Nemasys H are more variable and generally lower. It is important to check if this could be the cause for the moderate/variable results of the last two years. Looking at the results with the older larvae (L5 = 58% of population) the rank order is HF85 (95-100% control) followed by UK211 (~70% control) and *S.feltiae* (~70% control). Only HF85 is significant different from the other nematode treatments.

The results with *Steinernema feltiae* (NZ-S-CA) are promising like in 1993. In the field trial the treatment with 1.0x10E6/m^2 (17) has failed because of the bad quality of the nematodes. The treatment with 0.5x10E6/m^2 (applied 4 days earlier with the same batch as used in the pot trial) in the field is with 56% control reasonable.

GENERAL CONCLUSIONS

Code1* is an effective chemical. In pots the results are constant high during the last few years. A concentration of 12.5 or 25 g/ha (80% a.i.) is giving maximum control. In the field the results with the 20% a.i. formulation were good during the last few years. With the new formulation (80% a.i.) and a lower dose of the product formulation the results were only moderate this year. Next year the dose should therefore be raised to 100 g/ha (80% a.i.).

Code2* is giving variable results over the last few years and is therefore considered to be not effective as a treatment against the larvae of the black vine weevil.

Code3 is showing in the field the same variation in results as in the pot trial. Concentration and formulation of the product seem to have little influence on the efficacy of control.

Of the tested nematode strains *Heterorhabditis* sp.(NWE)(NI-H-F85) was the most effective one in the pot trial and in the field.

The UK-strain (Nemasys H) is giving only moderate results. There is reason to believe that a reduced quality of the product is causing this effect. Comparing of the former gel-formulation with the today's clay-formulation in a field trial is advisable. The differences between the several strains tested are much less if we look at the control of the older larvae (L4). In the field test HF85 is the better strain looking at the total reduction but also looking at the control of the older larvae (L5).

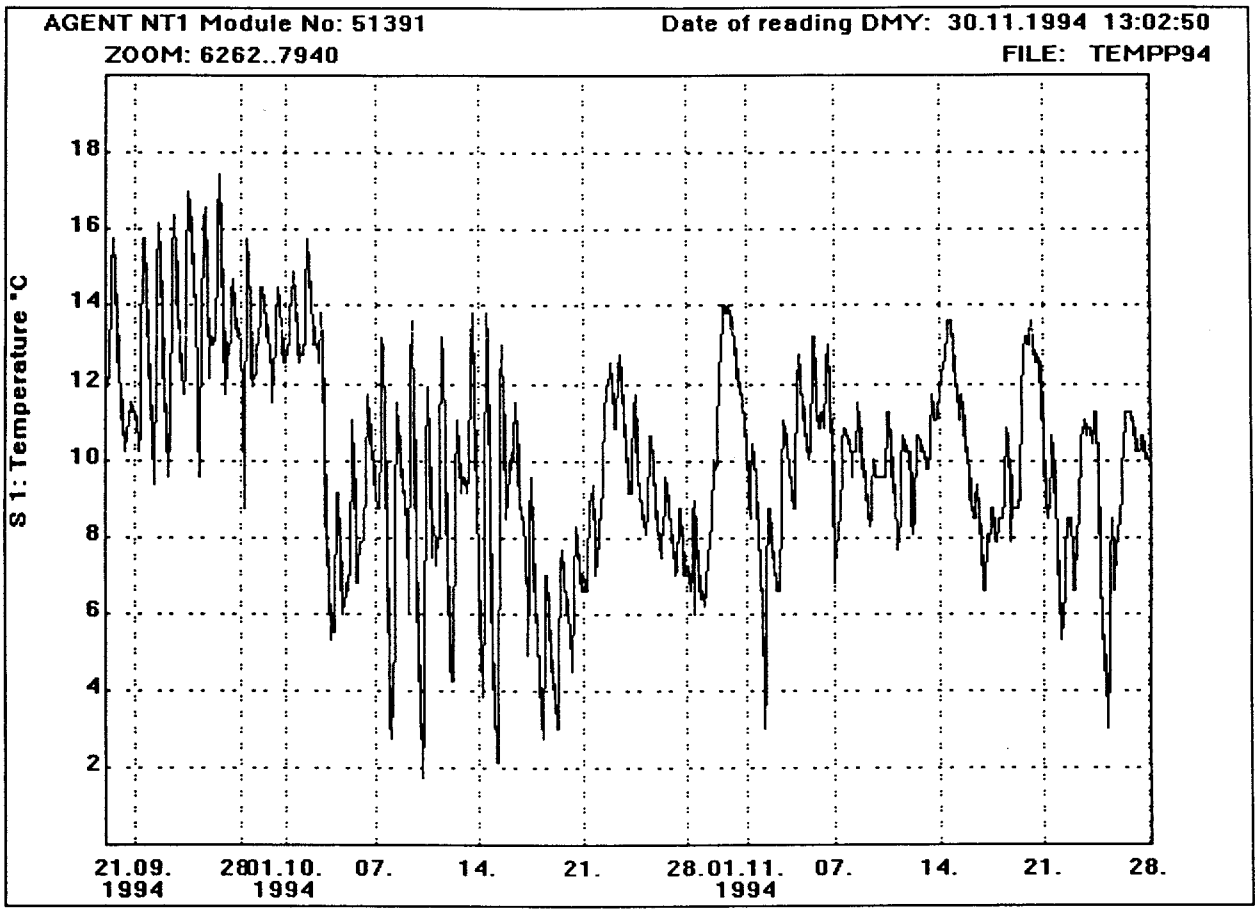
Steinernema feltiae (NZ-S-CA) is giving good control results in pots. The result is comparable with the results of 1993. Lowering the dose is giving a strong reduction in efficacy. In the field the results are reasonable but application with a good batch of nematodes at 1.0x10E6/m^2 is needed before this strain can be evaluated for its efficacy.

Although 50% reduction in the concentration of nematodes applied in the pots and the field are giving no statistically different results with the advised higher doses some more trials have to be performed to be sure that it is giving consistent and optimal control in time.

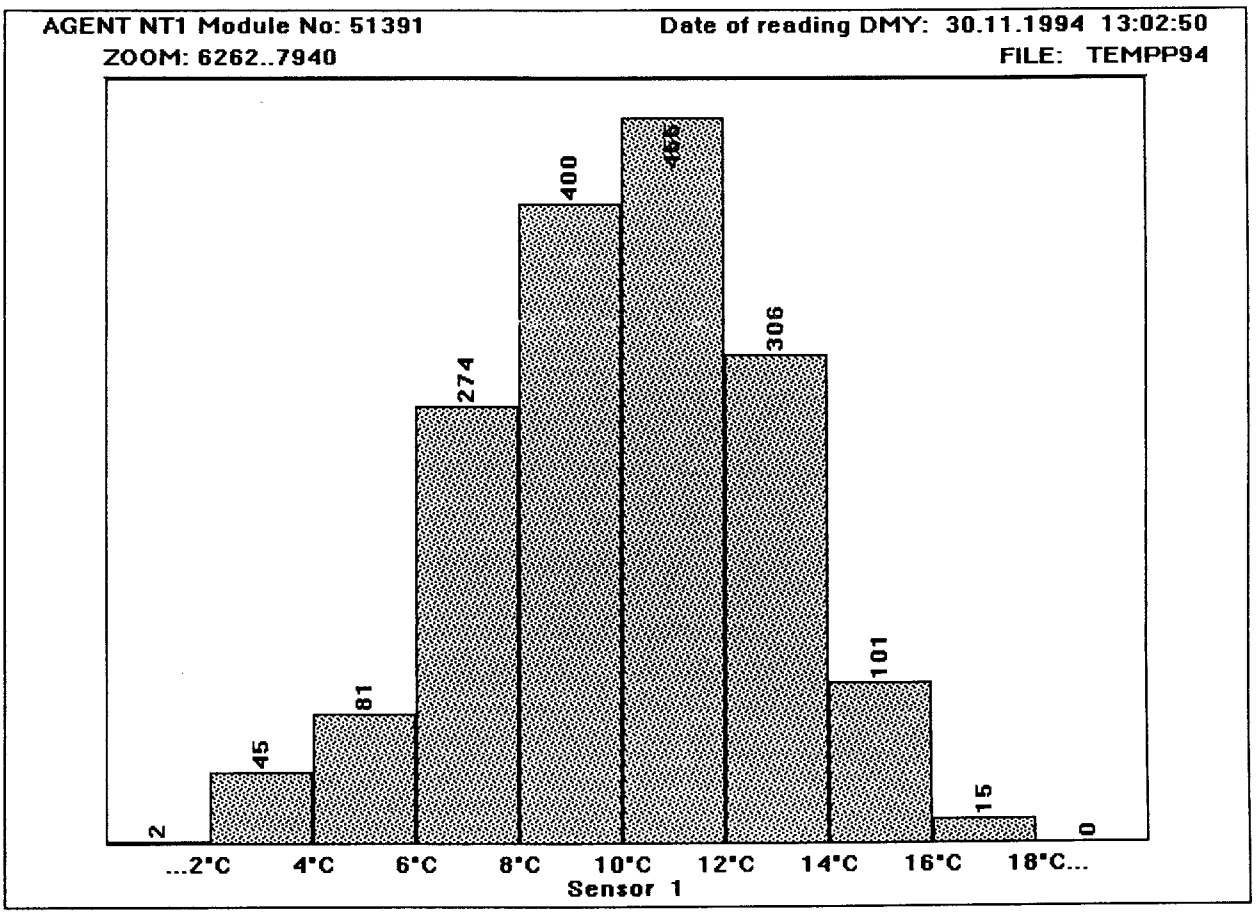
APPENDIX 1

Graphics of the soil temperature in resp. pots and field

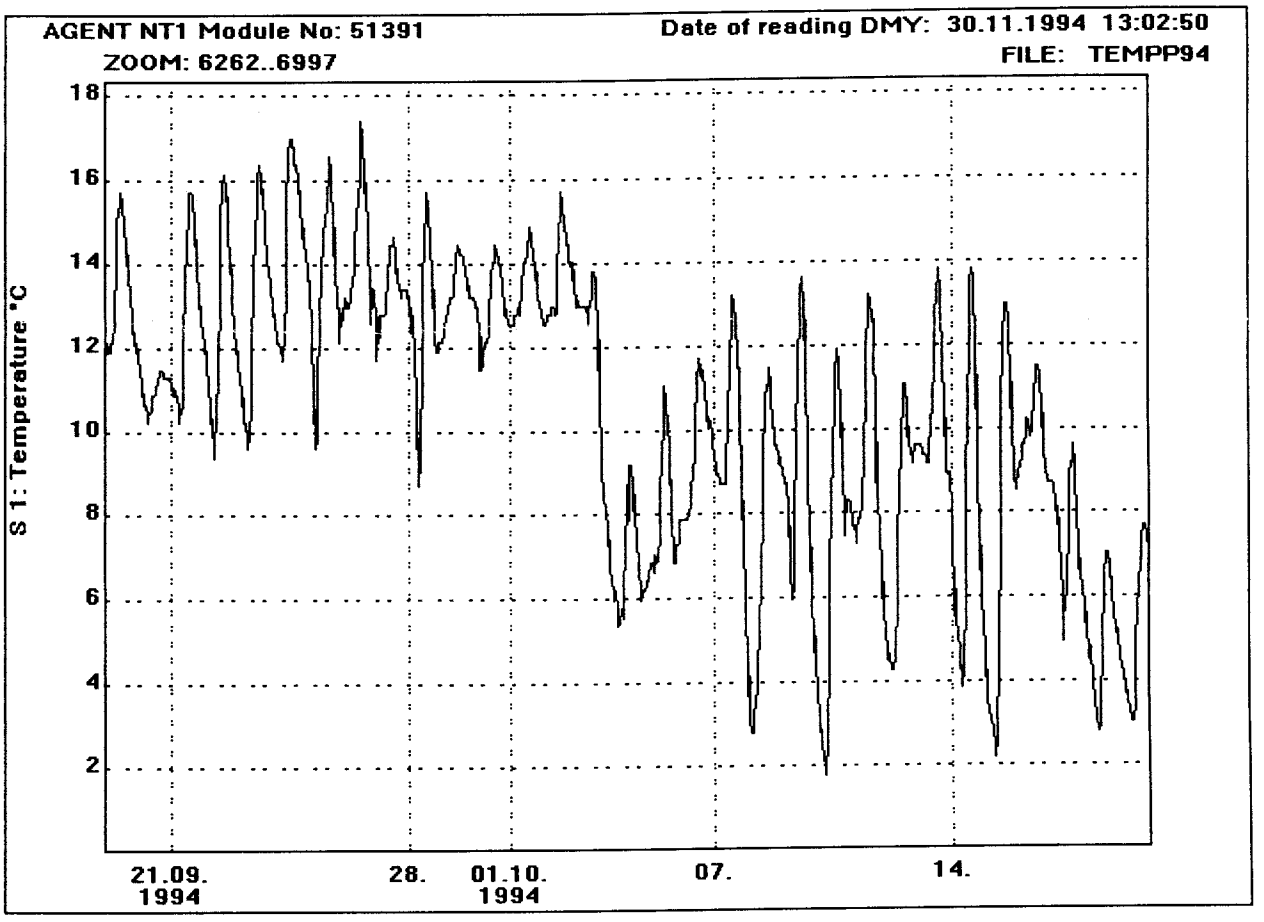
AGENT NT1: Module No: 51391
Programming info: 4102
Evaluation info: soil temperature in pots 1994
soil temperature in pots 1994



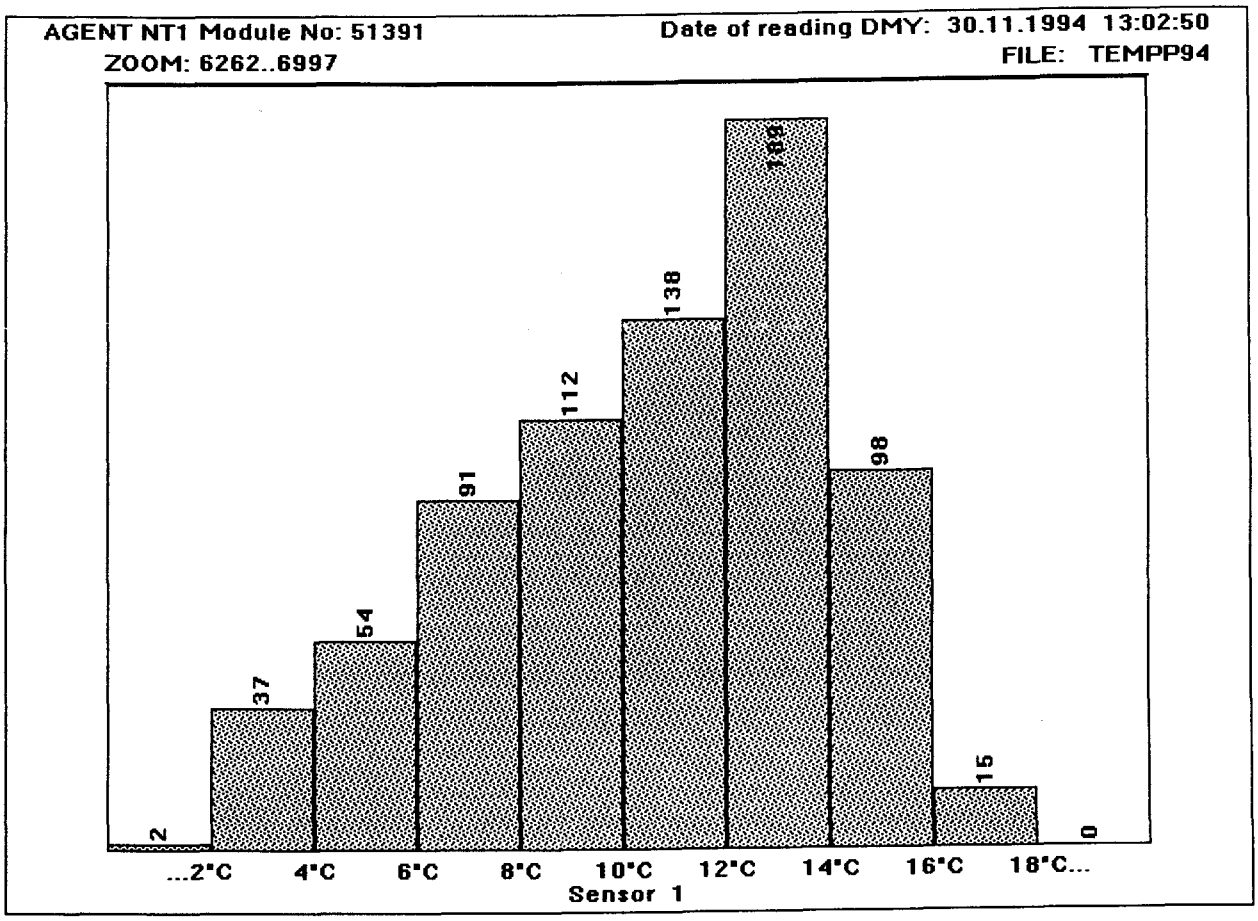
AGENT NT1: Module No: 51391
Programming info: 4102
Evaluation info: soil temperature in pots 1994
  histogram soil temperature in pots - 19/9 to 28/11 1994



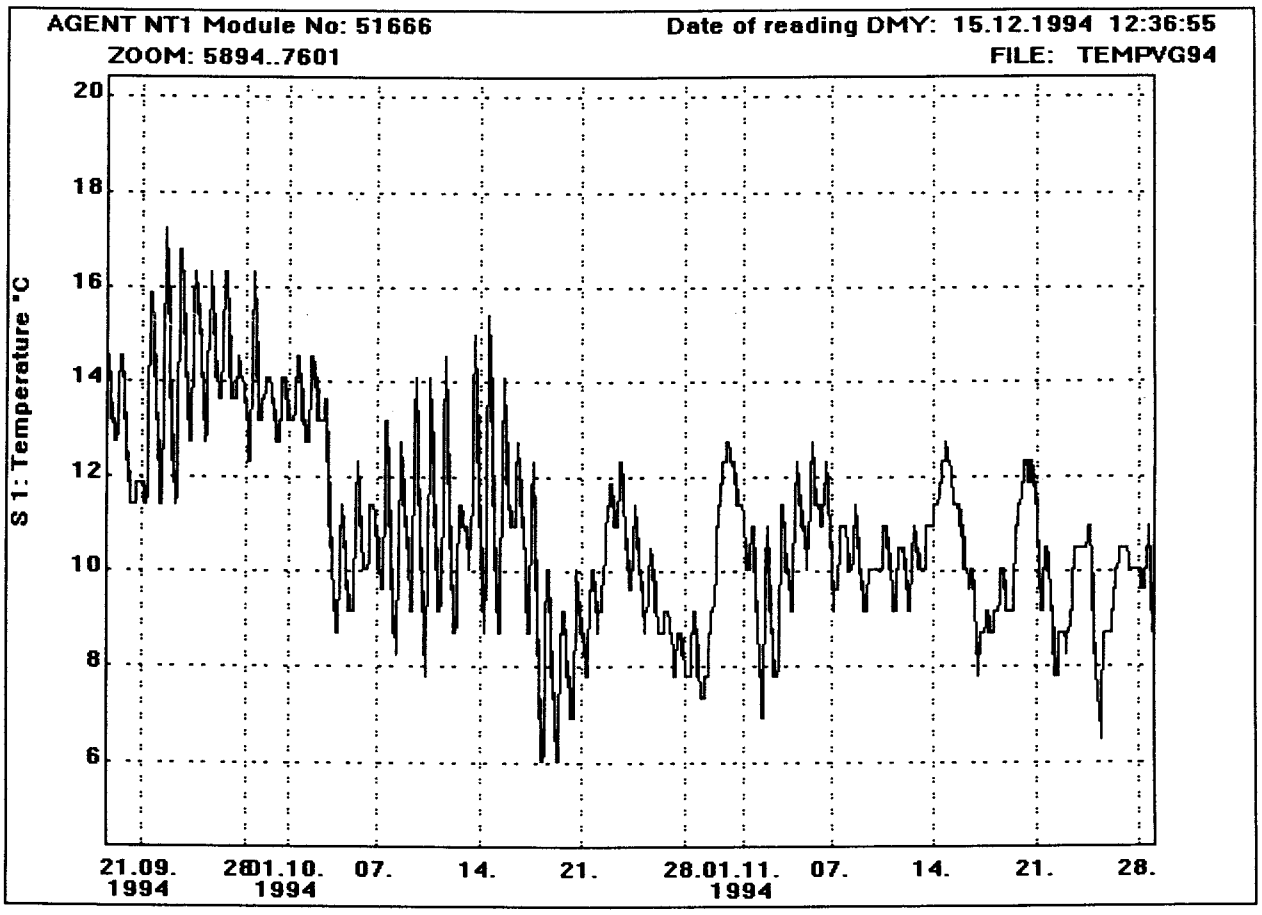
AGENT NT1: Module No: 51391
Programming info: 4102
Evaluation info: soil temperature in pots 1994
soil temperature in pots 19/9 to 19/10 1994



AGENT NT1: Module No: 51391
Programming info: 4102
Evaluation info: soil temperature in pots 1994
histogram temperature in pots 19/9 to 19/10 1994



AGENT NT1: Module No: 51666
Programming info:
Evaluation info: temperatuur in de vollegrond 1994
temperature of field soil 1994



AGENT NT1: Module No: 51666
Programming info:
Evaluation info: temperatuur in de vollegrond 1994
histogram temperature in field soil 1994